Experiment: Physical and Chemical Properties and Changes

Objectives

- Identify various physical and chemical properties of matter
- To distinguish between chemical changes and physical changes.

Materials Needed

Equipment:

- Hot plate
- 250 mL and 500 mL beakers
- Glass stirring rod
- 12-Well plate
- Eyedroppers
- Microspatula
- Evaporating dishes

Chemicals:

- Various elements and compounds
- Iodine crystals
- Sucrose crystals
- Acetone
- Steel wool
- Cupric sulfate pentahydrate crystals
- 10% sodium carbonate solution
- 10% sodium sulfate solution
- 6 M HCl
- 10% calcium chloride solution
- 10% sodium chloride solution
- De-ionized water

Discussion

Chemistry is the study of matter. It is very common for a chemist to need to describe a bit of matter as thoroughly as possible. In doing so, the chemist would certainly list *physical properties.* Many physical properties can be observed using our senses; color, crystal shape, and phase at room temperature are some examples. Other physical properties involve quantitative observations and so must be measured; density, specific heat capacity, and boiling point are three examples. A *physical change* is any change in a substance that does not involve a change in its chemical composition. During a physical change, no new chemical bonds are formed, and so the chemical composition remains the same. Examples of physical change are boiling, freezing, expanding, and dissolving.

Matter can also be characterized by its *chemical properties*. The chemical properties of a substance include all the chemical changes possible for that substance. A chemical change is one in which the substance is transformed to a new substance. That is, there is a change in the chemical composition of the substance. During a chemical change, the atoms are pulled apart from one another, rearranged, and put back in a new arrangement. Examples of chemical change are burning, rusting, fermenting, and decomposing.

In this experiment, you will first identify and record various physical properties of substances, using both qualitative and quantitative observations. In the second part, you will look at changes in matter and determine if they are physical or chemical.

Procedure

Part A: Physical Properties

1. Examine the various substances provided by your instructor and record your observations in Table 1 of the report sheet (Note: some substances may be toxic. As a precaution, do not open any containers with out the permission of your instructor.)

2a. Place a small crystal of iodine in a well of one well-plate and a small crystal of sucrose in a well of a second well-plate. Use an eyedropper to fill each well with distilled water and stir gently with a microspatula. Record whether each substance is completely soluble, partially soluble, or insoluble. Rinse the iodine into a designated waste container and the sucrose into the sink.

2b. Repeat the procedure using acetone as the solvent. You may need to rinse the iodine into another designated waste container (ask your instructor). The sucrose can be rinsed into the sink with water.

Part B: Physical and Chemical Changes

Complete Table 2 of the report sheet for each of the following systems.

1. Inspect a small piece of steel wool. Place it in an evaporating dish, and heat on a hot plate set to high. Allow the system to cool to room temperature. Observe and record any changes in the steel wool.
2. Inspect some cupric sulfate pentahydrate crystals, $CuSO_4 \cdot 5H_2O$. Place a few crystals in an evaporating dish and heat on a hot plate set to medium. Observe and record any changes in the salt. After the system has cooled to room temperature, add a few drops of water to the crystals. Observe and record any changes.
3. Place a few drops of a 10% sodium carbonate solution, Na_2CO_3, in one well of a well-plate and a few drops of a 10% sodium sulfate solution, Na_2SO_4, in a second well of the same well-plate. Add 2 or 3 drops of 6 M hydrochloric acid to each well. Observe and record any changes.
4. Place a few drops of a 10% sodium chloride solution, NaCl, in one well of a well-plate and a few drops of a 10% calcium chloride solution, $CaCl_2$, into a second well of the same well-plate. Add several drops of a 10% sodium carbonate solution to each well. Observe and record any changes.

To be performed by the instructor:

5. Inspect some iodine crystals, I_2. Place a few of the crystals in a dry 250 mL beaker and cover with an evaporating dish that contains ice, as shown in figure 2. In a fume hood, place the beaker on a hot plate set to medium. Observe and record any changes.
6. Fill a 500 or 1000 mL beaker about a third full with de-ionized water. Add a couple drops of phenolphthalein to the water. Gently cut a small piece of sodium metal and place it on a small section of filter paper. Place the filter paper, with metal on top, onto the surface of the water. Quickly cover the beaker with a large watch glass. Observe and record any changes.

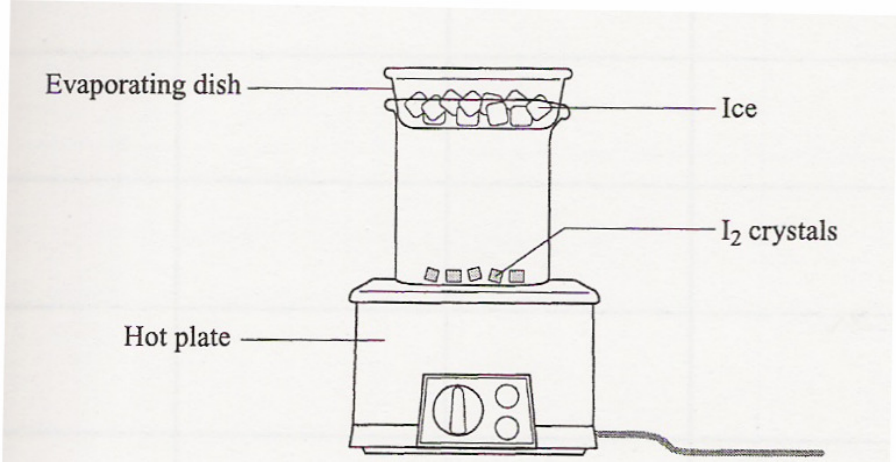

FIGURE 1

Report Sheet

Part A: Physical Properties

Table 1 (complete table)

Name of Substance	Chemical Formula	Phase at Room Temperature	Color	Other Physical Properties Observed	Element or Compound?

2. Solubility

   Iodine in water _____ Sucrose in water _____

   Iodine in acetone _____ Sucrose in acetone _____

Part B: Physical and Chemical Changes

Table 2 (complete table)

Procedure	**Observation**	**Physical Change or Chemical Change?**	**Evidence or Reasoning**
1. steel wool + heat			
2a. $CuSO_4 \cdot 5H_2O$ + heat			
2b. $CuSO_4$ + H_2O			
3a. Na_2CO_3 + HCl			
3b. Na_2SO_4 + HCl			
4a. NaCl + Na_2CO_3			
4b. $CaCl_2$ + Na_2CO_3			
5. I_2 + heat			
6. Na (metal) + H_2O			

Questions

1. Distinguish between a qualitative observation and a quantitative one. Give an example of each from this experiment.

2. Classify the following properties of sodium metal as physical or chemical:
   a. Silver metallic color _____
   b. Turns gray in air _____
   c. melts at 98°C _____
   d. Reacts explosively with chlorine _____
3. Classify the following changes as physical or chemical:
   a. steam condenses to liquid water on a cool surface _____
   b. baking soda dissolves in vinegar, producing bubbles _____
   c. mothballs gradually disappear at room temperature _____
   d. baking soda loses mass as it is heated _____
4. What are some of the ways you might distinguish between physical vs. chemical changes?

5. Are any of your answers in Question #4 potentially misleading? Consider your answers to Questions 2 & 3.